Appendix A:

Engineering Design Documents

Stream Diversions

TCRA Action Work Plan

submitted pursuant to

Administrative Settlement and Order on Consent for Removal Actions

(CERCLA Docket No. 10-2021-0034)

Stibnite Mine Site

Stibnite, Valley County, ID

Prepared for:

U.S. Environmental Protection Agency Region 10

United States Department of Agriculture Forest Service Intermountain Region

Prepared by:

Perpetua Resources

405 S 8th St,
Boise, ID, 83702

July 2021

Calculation Cover Sheet

Project: Stream Diversion Projects

Client: Perpetua Resources **Proj. No.** 17-080

Title: Hydrology, Hydraulics and Rip Rap Design

Prepared By, Name: J. Burgi

Prepared By, Signature: _____ **Date:** 6/22/2021

Peer Reviewed By, Name: _____

Peer Reviewed, Signature: _____ **Date:** _____

McMILLEN JACOBS ASSOCIATES

SUBJECT: Perpetua Resources
Stream Diversion Projects

BY: J. Burgi **CHK'D BY:**
DATE: 6/4/2021
PROJECT NO.: 17-080

Table of Content

McMILLEN JACOBS ASSOCIATES

SUBJECT: Perpetua Resources
Stream Diversion Projects

BY: J. Burgi **CHK'D BY:**
DATE: 6/4/2021
PROJECT NO.: 17-080

Purpose

The purpose of this calculation sheet is to compute an estimated value for the 100-yr event.

References

- *Rio ASE (2018). Surface Water Hydrology Report - Stibnite Gold Project*
- *Wood, Fosness, Skinner, Veilleux. (2017). Estimating Peak-Flow Frequency Statistics for Selected Gaged and Ungaged Sites in Naturally Flowing Streams and Rivers in Idaho. USGS*

Information - Input

The Hennessy Creek watershed contains a small drainage area that ranges in elevation from 6300 feet to 8800 feet. Due to its elevation and geographical location, the peak runoff flows are highly dependent on snow melt in the spring. Rio (2018) prepared a report summarizing the surface water hydrology in the area. The resulting regression equations from this report were used and compared with the regression equations prepared by the USGS (2017) for ungaged streams in Idaho. The contributing drainage areas for the DMEA and Smelter Flats have very similar characteristics.

A_H	0.72	mi^2	Hennessy Creek	GIS Watershed definition
A_{H2}	0.16	mi^2	Hennessy Side Slope	GIS Watershed definition
A_D	0.1	mi^2	DMEA	GIS Watershed definition
A_S	0.1	mi^2	Smelter Flats	GIS Watershed definition
P	31.4	in	Mean annual precipitation	StreamStats (USGS)

Calculation

Surface Water Hydrology Report - Rio ASE (2018)

$$Q_u = B * \left(P_u{}^b * DA_u{}^c\right)^d \quad \text{eq 7-4 (Rio, 2018)}$$

Qu		is discharge (cfs) for the selected frequency
B	0.0027	B is a constant based on regression trend line
Pu	31.4	Pu is the average annual precipitation (in)
DAu	0.72	DAu is drainage area (mi2) for the ungaged site

	100	25	10	
b	2.37	2.42	2.47	b is exponent for precipitation, and
c	0.936	0.941	0.944	c is exponent for drainage area
d	1.1051	1.069	1.0389	d is exponent for power curve

Table 7-2. Constants and Coefficients For Peak Flood Flow Discharge Estimates Regression Equations.

Annual Exceedance Probability	Recurrence Interval (Years)	Variable					
		a	B	b	c	d	R^2
0.995	1.005	0.899[1]	0.0035	2.976	0.925	0.7404	0.970
0.99	1.01	0.899[1]	0.0027	2.980	0.925	0.7714	0.961
0.95	1.05	0.901[1]	0.0017	3.011	0.927	0.8287	0.940
0.9	1.11	0.904[1]	0.0012	3.055	0.930	0.8593	0.926
0.8	1.25	0.908	0.0018	2.840	0.934	0.8946	0.930
0.6667	1.5	0.913	0.0020	2.750	0.939	0.9249	0.927
0.5	2	0.918	0.0021	2.670	0.943	0.9561	0.924
0.4292	2.33	0.919	0.0023	2.630	0.944	0.9645	0.923
0.2	5	0.922	0.0025	2.530	0.945	1.0104	0.918
0.1	10	0.922	0.0027	2.470	0.944	1.0389	0.915
0.04	25	0.921	0.0027	2.420	0.941	1.0692	0.912
0.02	50	0.919	0.0028	2.390	0.939	1.0873	0.910
0.01	100	0.916	0.0027	2.370	0.936	1.1051	0.908
0.005	200	0.914	0.0027	2.350	0.934	1.1210	0.906
0.002	500	0.912	0.0025	2.340	0.931	1.1379	0.903

1. Values were linearly extrapolated from the exponents associated with the 1.25- and 1.5-year recurrence intervals.

	100	25	10		
$Q_{100\text{-}H}$	16.01	14.49	13.57	cfs	Hennessy Creek
$Q_{100\text{-}H2}$	3.38	3.19	3.11	cfs	Hennessy Side Slope
$Q_{100\text{-}D}$	2.08	1.99	1.96	cfs	DMEA
$Q_{100\text{-}S}$	2.08	1.99	1.96	cfs	Smelter Flats

USGS (2017)

$$Q_{10} = 0.00279 * A^{0.944} * P^{2.47}$$ Table 4

$$Q_4 = 0.00420 * A^{0.941} * P^{2.42}$$

$$Q_1 = 0.00644 * A^{0.936} * P^{2.37}$$ Table 4

A 0.72 sq mi
P 31.4 in

	100	25	10		
$Q_{100\text{-}H}$	16.71	12.93	10.19	cfs	Hennessy Creek
$Q_{100\text{-}H2}$	4.09	3.14	2.46	cfs	Hennessy Side Slope
$Q_{100\text{-}D}$	2.63	2.02	1.58	cfs	DMEA
$Q_{100\text{-}S}$	2.63	2.02	1.58	cfs	Smelter Flats

Conclusion

The two regression equation calculations are based on similar information and as a result return very similar peak flows for the 100-year event. The USGS (2017) regression equation will be used for sizing of the hydraulic components of the diversion.

$Q_{100\text{-}H}$	16.71 cfs	Hennessey Creek
$Q_{100\text{-}H2}$	4.09 cfs	Hennessy Side Slope
$Q_{100\text{-}D}$	2.63 cfs	DMEA
$Q_{100\text{-}S}$	2.63 cfs	Smelter Flats

McMILLEN JACOBS ASSOCIATES

SUBJECT: Perpetua Resources **BY:** J. Burgi **CHK'D BY:**
Stream Diversions **DATE:** 6/4/2021
PROJECT NO.: 17-080

Purpose

The purpose of this calculation sheet is to calculate the open channel hydraulics for the alternatives based on channel geometry and slope.

References

- *Chow, Ven Te (1959). Open Channel Hydraulics, McGraw Hill*
- *Robinson, K.M. (1989). Design of Rock Chutes, American Society of Agricultural Engineers.*

Information - Input

$Q_{100\text{-}H}$	16.7	cfs	Hennessy Creek
$Q_{100\text{-}H2}$	4.1	cfs	Hennessy Side Slope
$Q_{100\text{-}D}$	2.6	cfs	DMEA
$Q_{100\text{-}S}$	2.6	cfs	Smelter Flats

Calculation

Flow calculations based on Manning's Formula

$$Q = \left(\frac{1.49}{n}\right) A \left(R_h{}^{\frac{2}{3}}\right) S^{\frac{1}{2}}$$

For each alternative, the profile was split into representative slope groups to calculate the depth of flow based on the flow rate, channel geometry and shape. The Manning's coefficient for Hennessy Alternative 2 was set to 0.025 assuming an irregular surface for the shotcrete.

Each alignment is split into representative reaches based on slope. For each reach, depth and manning's n are assumed and the velocity is calculated. The calculated area is found by dividing the Flow Rate (Q) by the calculated velocity. The initial area and calculated area are compared and the initial depth is iteratively modified until a solution is found.

Mannings n was then calcuated for each reach based on the D50 of the rip rap and the slope (see RipRap sheet).

Hennessy Alt1

Flow Rate, Q = 20.80 cfs Combined Hennessy and Side Slope

Station	Elev	Dist	ΔZ	S	n	d	B	SS	A	Pw	R_h	V (fps)
	ft	ft	ft	ft/ft		ft	ft	SS:1	ft^2	ft		
0	6260	500.0	-12	0.02	0.030	0.97	2.0	2.0	3.80	6.32	0.60	5.48
500	6248	1963.0	-120	0.06	0.039	0.87	2.0	2.0	3.24	5.88	0.55	6.43
2463	6128	437.0	-57	0.13	0.047	0.79	2.0	2.0	2.84	5.54	0.51	7.33
2900	6071											

Manning Coeff, n = 0.025 Shotcrete, wavy section, irregular
Flow Rate, Q = 16.70 cfs Hennessy Creek

Station	Elev	Dist	ΔZ	S	d	B	SS	A	Pw	R_h	V (fps)
	ft	ft	ft	ft/ft	ft	ft	SS:1	ft^2	ft		
0	6259	240	-150	0.63	0.15	10.0	1.0	1.53	10.43	0.15	13.11
240	6109	61	-6	0.10	0.26	10.0	1.0	2.69	10.74	0.25	7.44
301	6103	29	-49	1.69	0.11	10.0	1.0	1.13	10.32	0.11	17.74
330	6054	40	-12	0.30	0.19	10.0	1.0	1.91	10.53	0.18	10.47
370	6042										

DMEA Alt 1

Flow Rate, Q = 2.60 cfs Flow above DMEA

Station	Elev	Dist	ΔZ	S	n	d	B	SS	A	Pw	R_h	V (fps)
	ft	ft	ft	ft/ft		ft	ft	SS:1	ft^2	ft		
0	6633	103	-19.91	0.19	0.047	0.50	0.00	2.00	0.50	2.25	0.22	5.15
103	6613	127	-33.00	0.26	0.050	0.49	0.00	2.00	0.47	2.18	0.22	5.49
230	6580											

Smelter Flat

Flow Rate, Q = 2.60 cfs Flow from Smelter Flats hillside

Station	Elev	Dist	ΔZ	S	n	d	B	SS	A	Pw	R_h	V (fps)
	ft	ft	ft	ft/ft		ft	ft	SS:1	ft^2	ft		
0	6640	524	-3.50	0.01	0.021	0.50	1.00	2.00	0.99	3.22	0.31	2.64
524	6636	244	-41.40	0.17	0.043	0.31	1.00	2.00	0.51	2.40	0.21	5.09
768	6595	622	-20.80	0.03	0.030	0.40	1.00	2.00	0.71	2.77	0.26	3.66
1390	6574											

McMILLEN JACOBS ASSOCIATES

SUBJE Perpetua Resources **BY:** J. Burgi **CHK'D BY:**
Stream Diversions **DATE:** 6/4/2021
PROJECT NO.: 17-080

Purpose

The purpose of this calculation sheet is to calculate freeboard for the diversions based on 1 foot above 25-yr flow or 6 inches above 100-yr flow

References

- *Chow, Ven Te (1959). Open Channel Hydraulics, McGraw Hill*
- *Robinson, K.M. (1989). Design of Rock Chutes, American Society of Agricultural*

Information - Input

$Q25_{-H}$	12.9	cfs	Hennessy Creek
$Q25_{-H2}$	3.1	cfs	Hennessy Side Slope
$Q25_{-D}$	2.0	cfs	DMEA
$Q25_{-S}$	2.0	cfs	Smelter Flats

Calculation

Flow calculations based on Manning's Formula

$$Q = \left(\frac{1.49}{n}\right) A \left(R_h{}^{\frac{2}{3}}\right) S^{\frac{1}{2}}$$

For each alternative, the profile was split into representative slope groups to calculate the depth of flow based on the flow rate, channel geometry and shape. The Manning's coefficient for Hennessy Alternative 2 was set to 0.025 assuming an irregular surface for the shotcrete.

Each alignment is split into representative reaches based on slope. For each reach, depth and manning's n are assumed and the velocity is calculated. The calculated area is found by dividing the Flow Rate (Q) by the calculated velocity. The initial area and calculated area are compared and the initial depth is iteratively modified until a solution is found.

McMILLEN JACOBS ASSOCIATES

Hennessy Alt1

Flow Rate, Q = 16.00 cfs Combined Hennessy and Side Slope

Station	Elev	Dist	ΔZ	S	n	d	B	SS	A	Pw	R_h	V (fps)
	ft	ft	ft	ft/ft		ft	ft	SS:1	ft^2	ft		
0	6260	500.0	-12	0.02	0.030	0.85	2.0	2.0	3.13	5.79	0.54	5.11
500	6248	1963.0	-120	0.06	0.039	0.76	2.0	2.0	2.67	5.40	0.50	5.99
2463	6128	437.0	-57	0.13	0.047	0.69	2.0	2.0	2.35	5.10	0.46	6.82
2900	6071											

Hennessy Alt2

Manning Coeff, n = 0.025 Shotcrete, wavy section, irregular
Flow Rate, Q = 12.90 cfs Hennessy Creek

Station	Elev	Dist	ΔZ	S	d	B	SS	A	Pw	R_h	V (fps)
	ft	ft	ft	ft/ft	ft	ft	SS:1	ft^2	ft		
0	6259	240	-150	0.63	0.12	10.0	1.0	1.17	10.33	0.11	11.03
240	6109	61	-6	0.10	0.20	10.0	1.0	2.06	10.57	0.19	6.28
301	6103	29	-49	1.69	0.09	10.0	1.0	0.87	10.24	0.08	14.92
330	6054	40	-12	0.30	0.14	10.0	1.0	1.46	10.41	0.14	8.82
370	6042										

DMEA Alt 1

Flow Rate, Q = 2.00 cfs Flow above DMEA

Station	Elev	Dist	ΔZ	S	n	d	B	SS	A	Pw	R_h	V (fps)
	ft	ft	ft	ft/ft		ft	ft	SS:1	ft^2	ft		
0	6633	103	-19.91	0.19	0.047	0.46	0.00	2.00	0.41	2.04	0.20	4.82
103	6613	127	-33.00	0.26	0.050	0.44	0.00	2.00	0.39	1.97	0.20	5.15
230	6580											

Smelter Flat

Flow Rate, Q = 2.00 cfs Flow from Smelter Flats hillside

Station	Elev	Dist	ΔZ	S	n	d	B	SS	A	Pw	R_h	V (fps)
	ft	ft	ft	ft/ft		ft	ft	SS:1	ft^2	ft		
0	6638	535	-4.72	0.01	0.021	0.41	1.00	2.00	0.73	2.81	0.26	2.72
535	6633	271	-39.00	0.14	0.043	0.29	1.00	2.00	0.45	2.28	0.20	4.45
806	6594	584	-20.00	0.03	0.030	0.34	1.00	2.00	0.58	2.54	0.23	3.44
1390	6574											

Conclusion

There is no universally accepted rule for determining the amount of freeboard that is needed. FHWA - Design of Roadside Channels with Flexible Linings" suggest that 6" above the design flow is appropriate. Idaho stream alteration rules suggest 1 foot above the 25-year flow. The tables below demonstrate the differences, and the recommended design depth for the channels.

Hennessy Alt1

Station	Total Channel Depth (ft)		
	1' above 25	6" above 100	Design
0	1.85	1.47	2.00
500	1.76	1.37	2.00
2463	1.69	1.29	2.00
2900			

DMEA Alt 1

Station	Total Channel Depth (ft)		
	1' above 25	6" above 100	Design
0	1.46	1.00	1.50
103	1.44	0.99	1.50
230			

Smelter Flat

Station	Total Channel Depth (ft)		
	1' above 25	6" above 100	Design
0	1.41	1.00	1.50
535	1.29	0.81	1.50
806	1.34	0.90	1.50
1390			

SUBJECT: Perpetua Resources Diversions **BY:** J. Burgi **CHK'D BY:**

DATE: 6/4/2021

PROJECT NO.: 17-080

Purpose

The purpose of this calculation sheet is to size the riprap for the channel.

References

• *Robinson, K.M. (1989). Design of Rock Chutes, American Society of Agricultural Engineers.*
• *Federal Highway Administration (FHWA). 1989. Design of Riprap Revetment*.
Hydraulic Engineering Circular, No. 11 (HEC-11). U.S. Dept. of Transportation:
• U.S. Army Corps of Engineers (USACE). 1991. *Hydraulic Design of Flood Control Channels*. Engineer Manual 1110-2-1601. Washington D.C., Revised 1994.

Information - Input

$Q_{100\text{-}H}$	16.7	cfs	Hennessy Creek
$Q_{100\text{-}H2}$	4.1	cfs	Hennessy Side Slope
$Q_{100\text{-}D}$	2.6	cfs	DMEA
$Q_{100\text{-}S}$	2.6	cfs	Smelter Flats

Calculation

USACE, Hydraulic Design of Flood Control Channels - EM-1110-2-1601, 1 July 1991

Mild Slope:

$$D_{30} = S_f C_s C_v C_t * d\left(\left(\frac{\gamma_W}{\gamma_S - \gamma_W}\right)^{0.5} * \frac{V}{\sqrt{K_l g d}}\right)^{2.5}$$

Steep slope (2% - 20%):

$$D_{30} = \frac{1.95 S^{0.555} q^{2/3}}{g^{1/3}}$$

D_{50}/D_{30} =	1.3	Stone Size
Sf =	1.25	Safety factor
Cs =	0.3	Stability coefficient for incipient failure, 0.3 angular rock
Cv =	1	Vertical velocity distribution coefficient, 1 for straight channels
Ct =	1	Thickness coefficient, 1 for (1*D100 or 1.5 * D50)
d =		local depth of flow
γ	165	unit weight of stone
γ	62.4	unit weight of water
V =		local depth averaged velocity
θ =	26.6	
ϕ =	40	
K_1 =	0.718	

HEC-11

$$D_{50} = \frac{0.001 * V^3}{\left(d^{0.5} * {K_1}^{1.5}\right)} \quad K_1 = \left[1 - \left(\frac{sin^2\theta}{sin^2\emptyset}\right)\right]^{0.5}$$

Used for flows greater than 1.5 m^3/s - 52.9 cfs

Robinson

0.1 < S <0.4 $$D_{50} = \left(\frac{(q * S^{0.58})}{8.06E-6}\right)^{1/1.89}$$

S < 0.1 $$D_{50} = \left(\frac{(q * S^{1.5})}{9.76E-7}\right)^{1/1.89}$$

Applies to rock chutes constructed with angular riprap with layer thickness of 2D50 for slopes between 2% and 40%. Rock specific gravity ranging between 2.54 and 2.82

$$n = 0.0292 * (D_{50} * S)^{1.47}$$

Hennessy Alt1

Station	S	d	V (fps)
	ft/ft	ft	
0	0.024	0.966	5.48
500	0.0611	0.867	6.43
2463	0.1304	0.792	7.33
2900			

HEC-11	USACE		Robinson	
	Mild	Steep		
D_{50} (in)	D_{50} (in)	D_{50} (in)	D_{50} (in)	n
3.30	NA	3.66	1.92	0.030
5.63	NA	6.37	4.25	0.039
8.72	NA	9.97	7.53	0.047

Average
D_{50} (in)
2.96
5.42
8.74

DMEA Alt 1

Station	S	d	V (fps)
	ft/ft	ft	
0	0.193	0.50	5.15
103	0.260	0.49	5.49
230			

HEC-11	USACE		Robinson	
	Mild	Steep		
D_{50} (in)	D_{50} (in)	D_{50} (in)	D_{50} (in)	n
3.80	NA	7.24	5.54	0.047
4.69	NA	NA	6.17	0.050

Average
D_{50} (in)
5.53
5.43

Smelter Flats

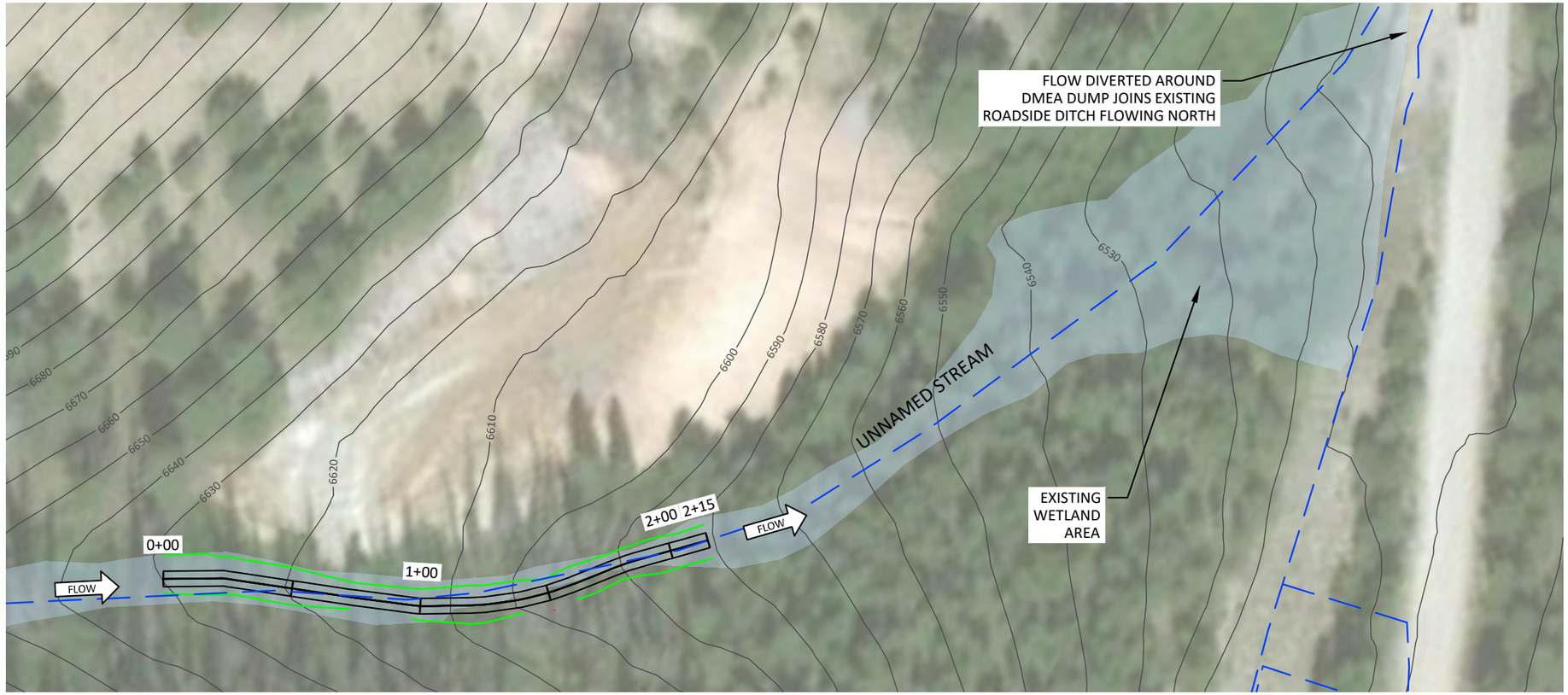
Station	S	d	V (fps)
	ft/ft	ft	
0	0.007	0.50	2.64
524	0.170	0.31	5.09
768	0.033	0.40	3.66
1390			

HEC-11	USACE		Robinson	
	Mild	Steep		
D_{50} (in)	D_{50} (in)	D_{50} (in)	D_{50} (in)	n
0.51	0.83	NA	0.32	0.019
4.63	NA	4.88	4.12	0.045
1.54	NA	1.86	1.27	0.030

Average
D_{50} (in)
0.56
4.54
1.56

Conclusion

D_{50} = 6in is recommended for the DMEA diversion and for Hennessy Alt1 diversion except for the steep section of the Hennessy diversion where D_{50} = 9.5in should be used. Smaller riprap may be used for Smelter Flats (D_{50} = 3in).



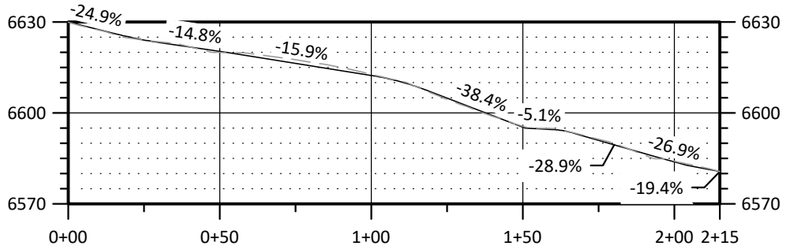
PLAN

SCALE: 1" = 50'

SHEET KEY NOTES:

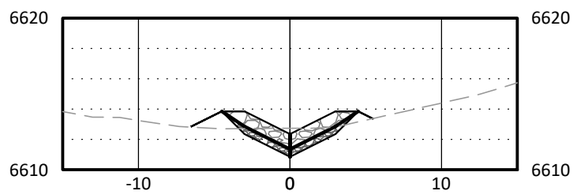
A DITCH TO BE LINED WITH GEOSYNTHETIC LINER, BASE MATERIAL AND RIP RAP SIZED TO BE STABLE AT 100-YR DESIGN FLOW. UPSTREAM AND DOWNSTREAM LIMITS OF WORK AND LINED/UNLINED SEGMENTS WILL BE DETERMINED AFTER STREAM DIVERSION CHANNEL FIELD INVESTIGATIONS.

DMEA DIVERSION ALT 1		
ITEM	QUANTITY	UNIT
EXCAVATION - CUT	40	CY
BACKFILL - FILL	50	CY
RIPRAP	58	CY
BASE	29	CY
GEOSYNTHETIC LINER	2,355	SF



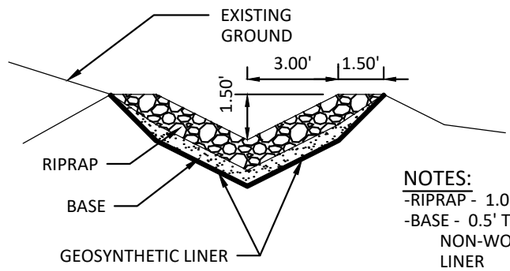
PROFILE

HORZ. SCALE: 1" = 50'
VERT. SCALE: 1" = 50'



SECTION 1+00

SCALE: NTS



NOTES:
-RIPRAP - 1.0' THICK
-BASE - 0.5' THICK GRAVEL OR NON-WOVEN GEOTEXTILE TO PROTECT LINER
-GEOSYNTHETIC LINER TYPE AND NEED FOR BEDDING, BASE, AND ANCHORING TO BE DETERMINED IN SUBSEQUENT DESIGN PHASES

TYPICAL SECTION

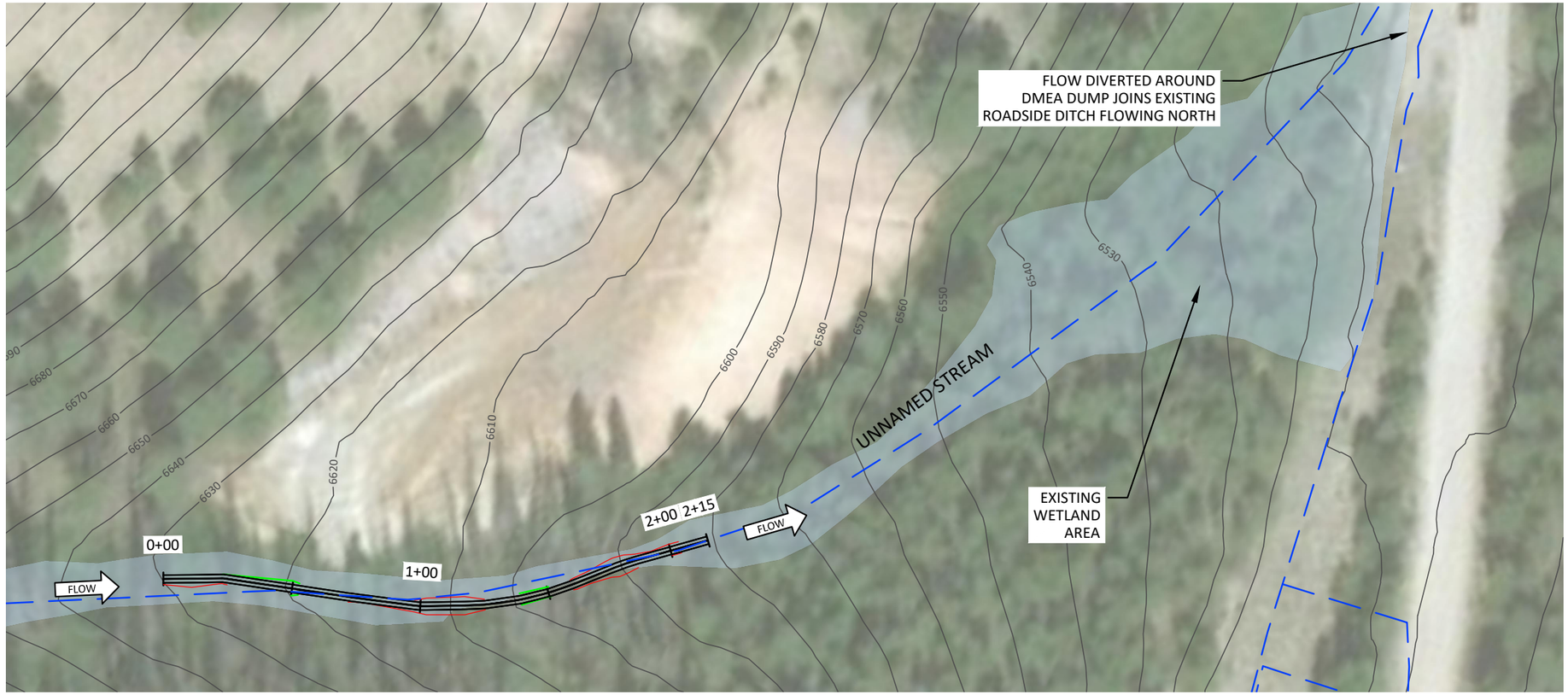
SCALE: NTS

McMILLEN JACOBS ASSOCIATES

PERPETUA RESOURCES
CERCLA PROJECT
DMEA DIVERSION
ALTERNATIVE 1

D-1

JUNE 2021



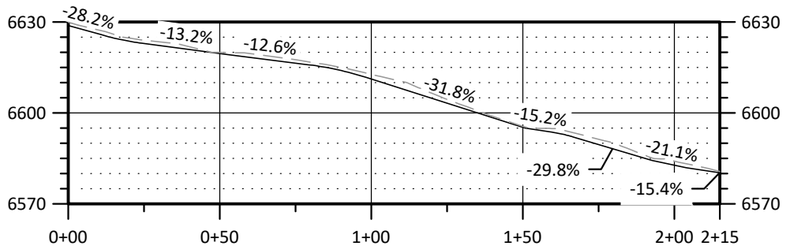
PLAN

SCALE: 1" = 50'

SHEET KEY NOTES:

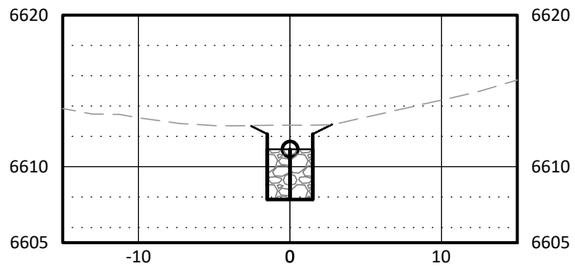
A DITCH TO BE LINED WITH GEOSYNTHETIC LINER, BASE MATERIAL AND RIP RAP SIZED TO BE STABLE AT 100-YR DESIGN FLOW. UPSTREAM AND DOWNSTREAM LIMITS OF WORK AND LINED/UNLINED SEGMENTS WILL BE DETERMINED AFTER STREAM DIVERSION CHANNEL FIELD INVESTIGATIONS.

DMEA DIVERSION ALT 1		
ITEM	QUANTITY	UNIT
EXCAVATION - CUT	91	CY
BACKFILL - FILL	7	CY
RIPRAP	76	CY
BASE	0	CY
GEOSYNTHETIC LINER	2,355	SF



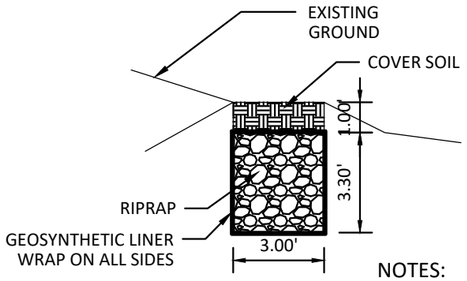
PROFILE

HORZ. SCALE: 1" = 50'
VERT. SCALE: 1" = 50'



SECTION 1+00

SCALE: NTS



NOTES:
-RIPRAP - 3.0' X 3.3'
--GEOSYNTHETIC LINER TYPE AND NEED FOR PROTECTIVE LAYER TO BE DETERMINED IN SUBSEQUENT DESIGN PHASES

TYPICAL SECTION

SCALE: NTS

McMILLEN JACOBS ASSOCIATES

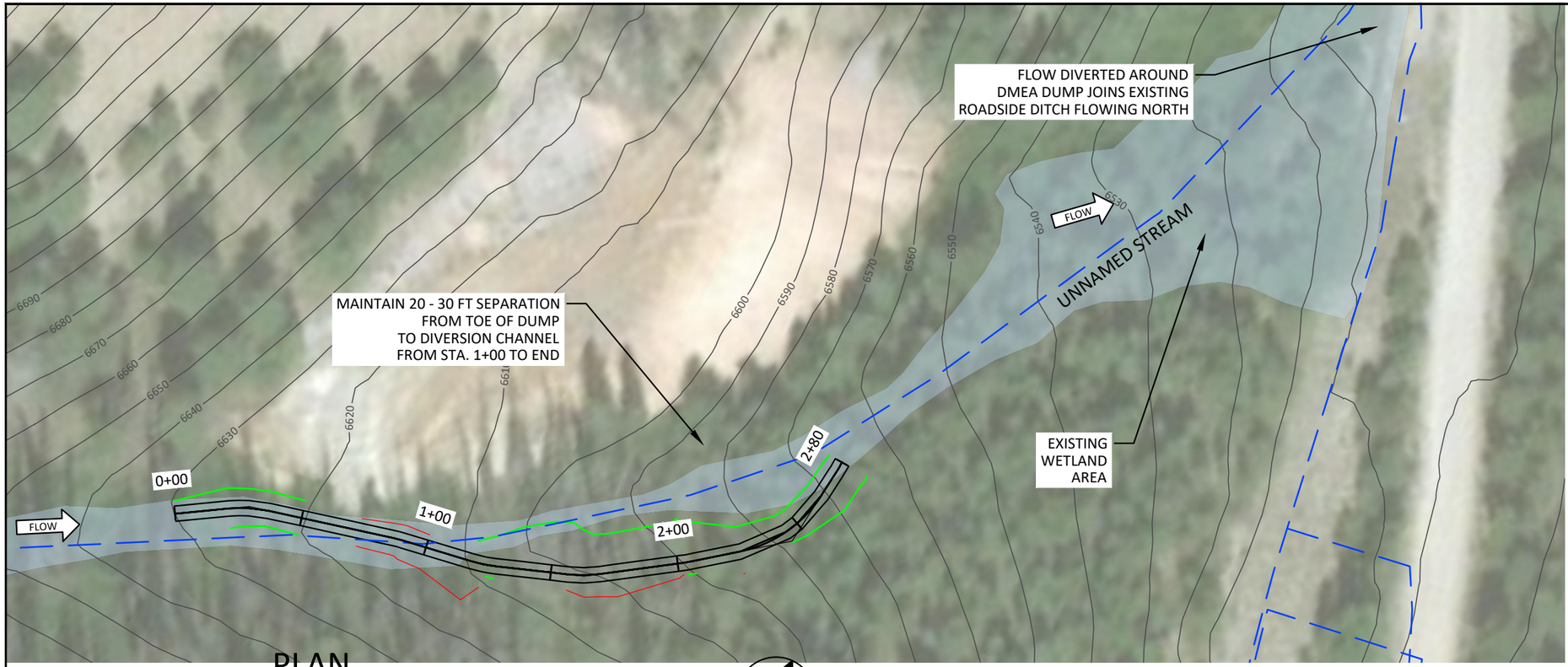
PERPETUA RESOURCES

CERCLA PROJECT

DMEA DIVERSION
ALTERNATIVE 4

D-4

JUNE 2021



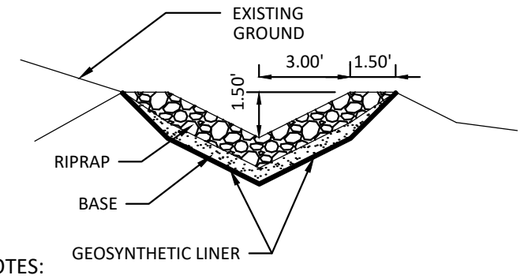
PLAN

SCALE: 1" = 50'

SHEET KEY NOTES:

A DITCH TO BE LINED WITH GEOSYNTHETIC LINER, BASE MATERIAL AND RIP RAP SIZED TO BE STABLE AT 100-YR DESIGN FLOW. UPSTREAM AND DOWNSTREAM LIMITS OF WORK AND LINED/UNLINED SEGMENTS WILL BE DETERMINED AFTER STREAM DIVERSION CHANNEL FIELD INVESTIGATIONS.

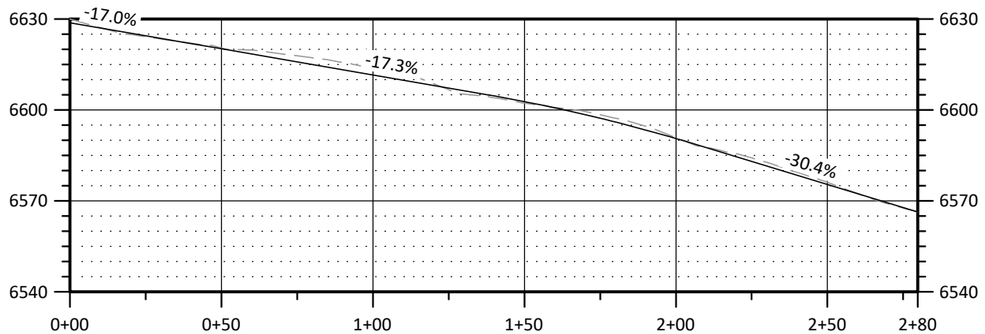
DMEA DIVERSION ALT 1		
ITEM	QUANTITY	UNIT
EXCAVATION - CUT	96	CY
BACKFILL - FILL	162	CY
RIPRAP	79	CY
BASE	40	CY
GEOSYNTHETIC LINER	3,080	SF



NOTES:
-RIPRAP - 1.0' THICK
-BASE - 0.5' THICK GRAVEL OR NON-WOVEN GEOTEXTILE TO PROTECT LINER
-GEOSYNTHETIC LINER TYPE AND NEED FOR BEDDING, BASE, AND ANCHORING TO BE DETERMINED IN SUBSEQUENT DESIGN PHASES

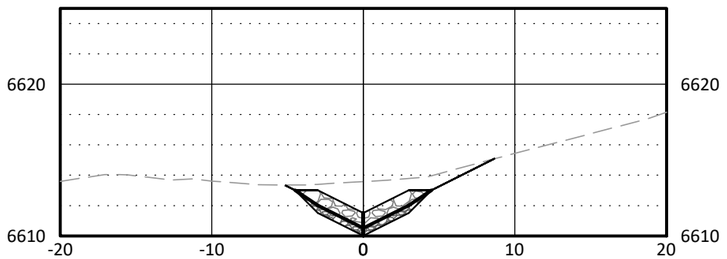
TYPICAL SECTION

SCALE: NTS



PROFILE

HORZ. SCALE: 1" = 50'
VERT. SCALE: 1" = 50'



SECTION 1+00

SCALE: NTS

McMILLEN JACOBS ASSOCIATES

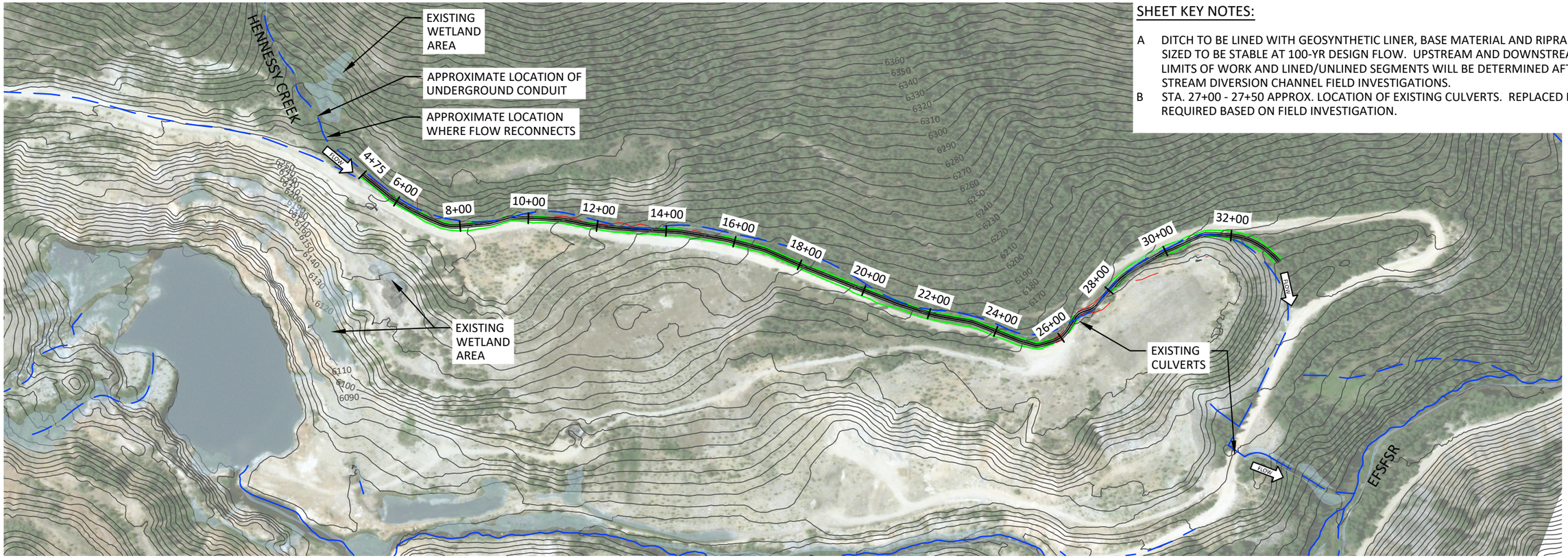
PERPETUA RESOURCES

CERCLA PROJECT

DMEA DIVERSION
ALTERNATIVE 5

D-5

JUNE 2021



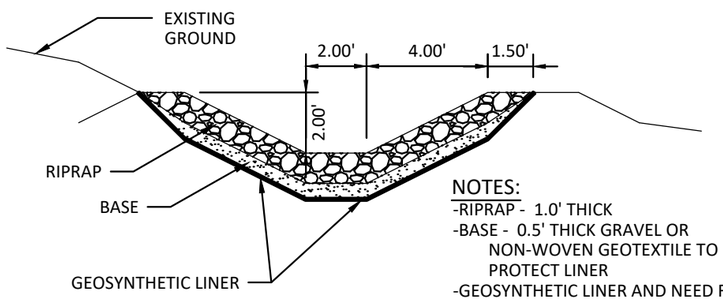
SHEET KEY NOTES:

A DITCH TO BE LINED WITH GEOSYNTHETIC LINER, BASE MATERIAL AND RIPRAP SIZED TO BE STABLE AT 100-YR DESIGN FLOW. UPSTREAM AND DOWNSTREAM LIMITS OF WORK AND LINED/UNLINED SEGMENTS WILL BE DETERMINED AFTER STREAM DIVERSION CHANNEL FIELD INVESTIGATIONS.

B STA. 27+00 - 27+50 APPROX. LOCATION OF EXISTING CULVERTS. REPLACED IF REQUIRED BASED ON FIELD INVESTIGATION.

PLAN

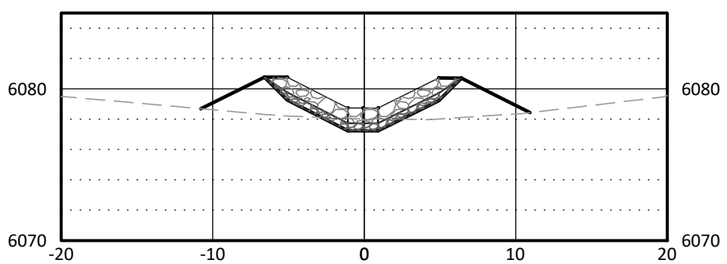
SCALE: 1" = 300'



NOTES:
-RIPRAP - 1.0' THICK
-BASE - 0.5' THICK GRAVEL OR NON-WOVEN GEOTEXTILE TO PROTECT LINER
-GEOSYNTHETIC LINER AND NEED FOR BEDDING, BASE AND ANCHORING TO BE DETERMINED IN SUBSEQUENT DESIGN PHASES

TYPICAL SECTION

SCALE: NTS



SECTION 28+50

SCALE: NTS

HENNESSY DIVERSION ALT 1		
ITEM	QUANTITY	UNIT
EXCAVATION - CUT	1,850	CY
BACKFILL - FILL	1,870	CY
RIPRAP	1,230	CY
BASE	615	CY
GEOSYNTHETIC LINER	43,900	SF

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PERPETUA RESOURCES

CERCLA PROJECT

HENNESSY CREEK DIVERSION
ALTERNATIVE 1 - PLAN VIEW

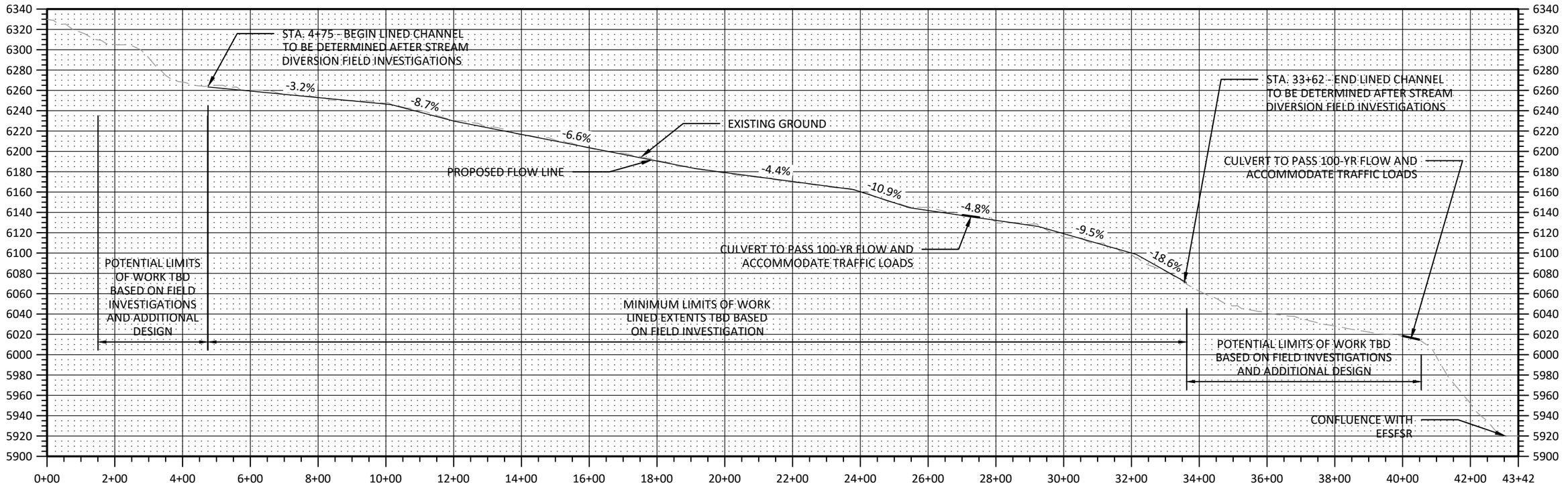
H-1a

JUNE 2021

SHEET KEY NOTES:

A DITCH TO BE LINED WITH GEOSYNTHETIC LINER, BASE MATERIAL AND RIPRAP SIZED TO BE STABLE AT 100-YR DESIGN FLOW. UPSTREAM AND DOWNSTREAM LIMITS OF WORK AND LINED/UNLINED SEGMENTS WILL BE DETERMINED AFTER STREAM DIVERSION CHANNEL FIELD INVESTIGATIONS.

B STA. 27+00 - 27+50 APPROX. LOCATION OF EXISTING CULVERTS. REPLACED IF REQUIRED BASED ON FIELD INVESTIGATION.



PROFILE

HORZ. SCALE: 1" = 300'
VERT. SCALE: 1" = 50'

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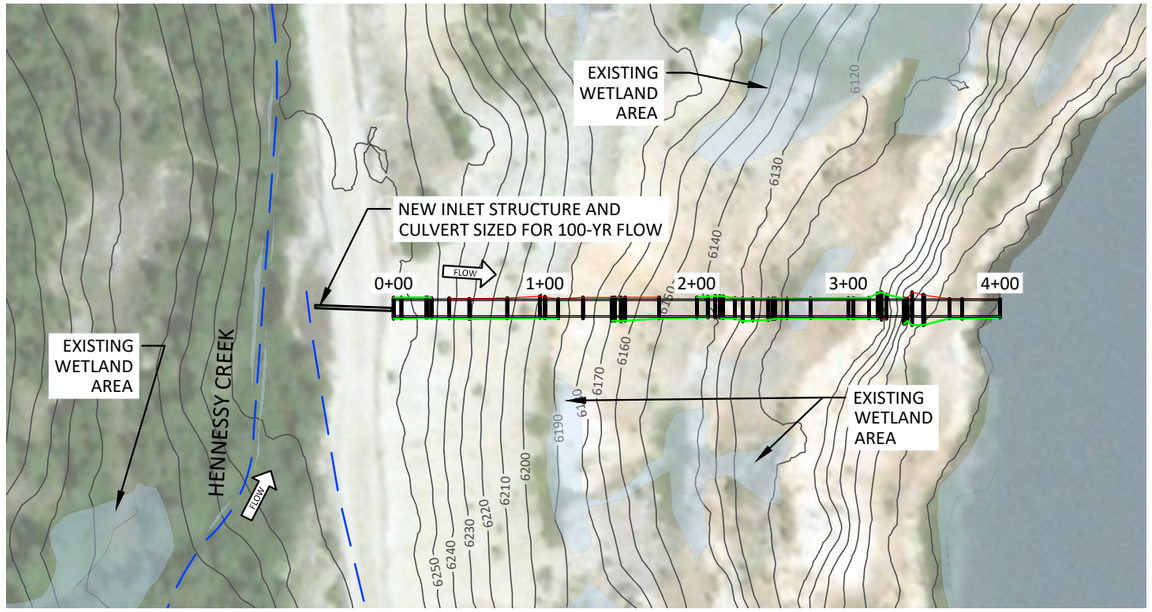
PERPETUA RESOURCES

CERCLA PROJECT

HENNESSY CREEK DIVERSION
ALTERNATIVE 1 - PROFILE

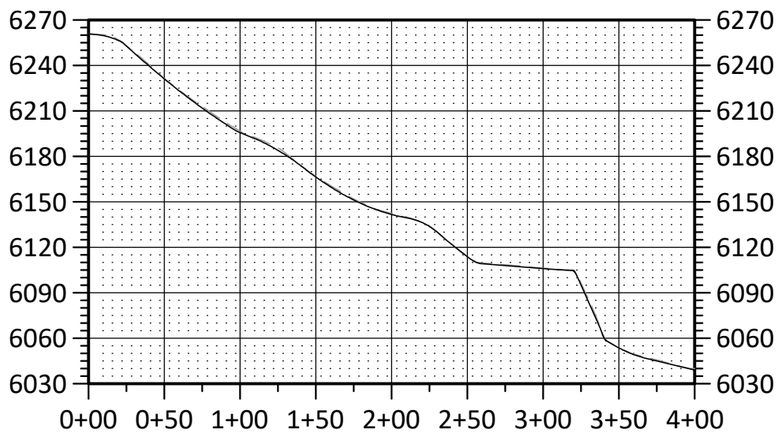
H-1b

JUNE 2021



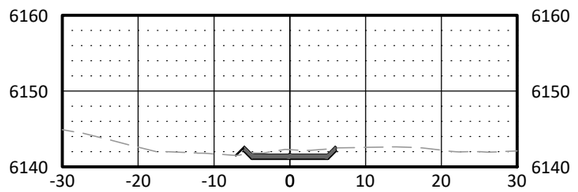
PLAN

SCALE: 1" = 100'



PROFILE

HORZ. SCALE: 1" = 100'
VERT. SCALE: 1" = 100'



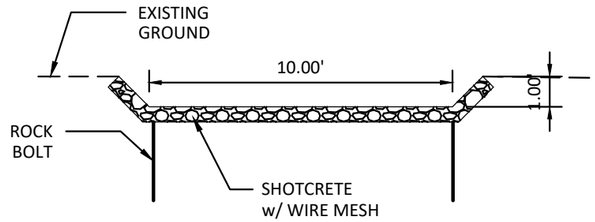
SECTION 2+00

SCALE: NTS

SHEET KEY NOTES:

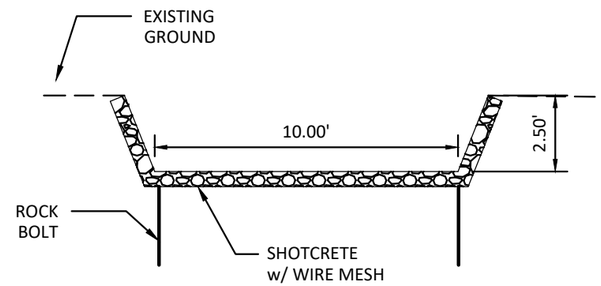
A STA. 0+00 - 4+00 - PREPARE AND SHAPE EXISTING HIGHWALL AND PROTECT WITH SHOTCRETE.
B INSTALL NEW INLET STRUCTURE AND CULVERT TO PASS THE 100-YR DESIGN FLOW.
C DESIGN OUTLET TO TO BE DETERMINED FOR ENERGY DISSIPATION

HENNESSY DIVERSION ALT 2		
ITEM	QUANTITY	UNIT
EXCAVATION - CUT	170	CY
SHOTCRETE w/ WIRE MESH	90	CY
ROCK BOLTS	74	EA
CULVERT	50	LF



TYPICAL STEEP SECTION

SCALE: NTS



TYPICAL FLAT SECTION AT BENCHES

SCALE: NTS

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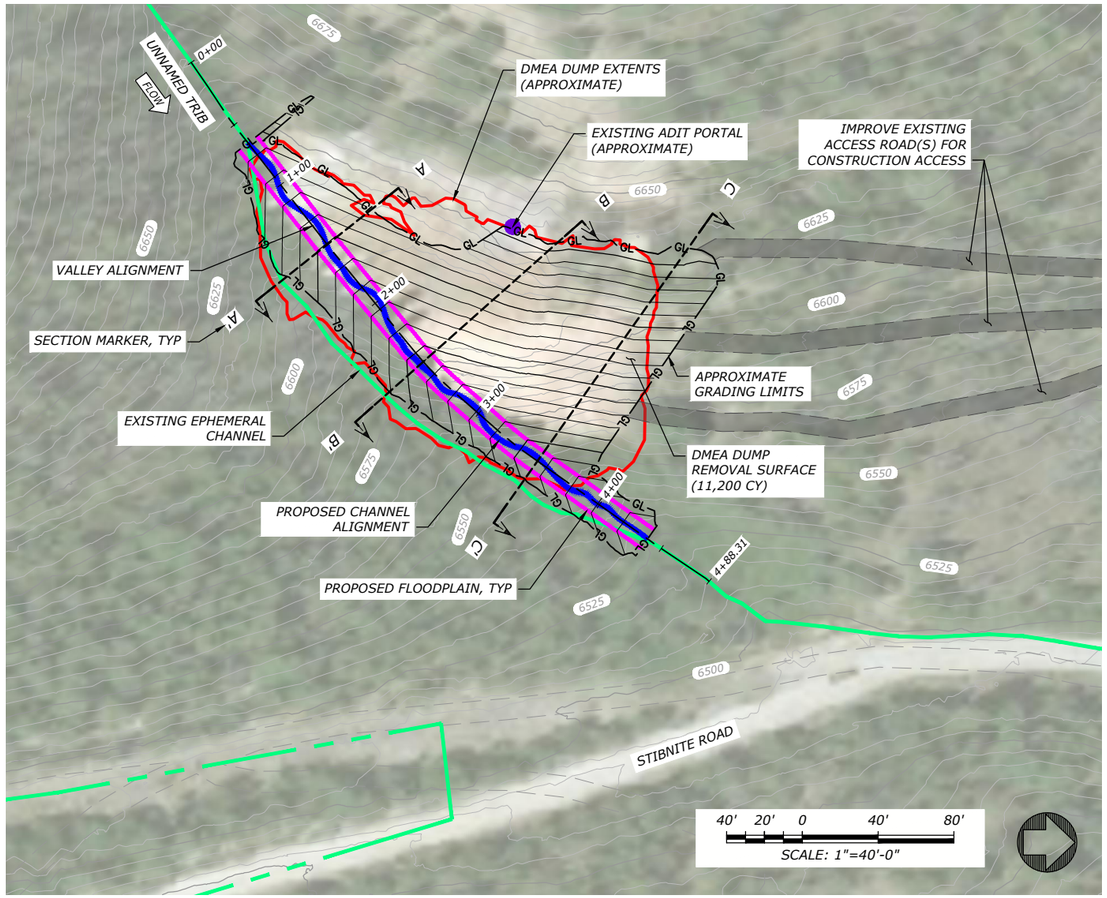
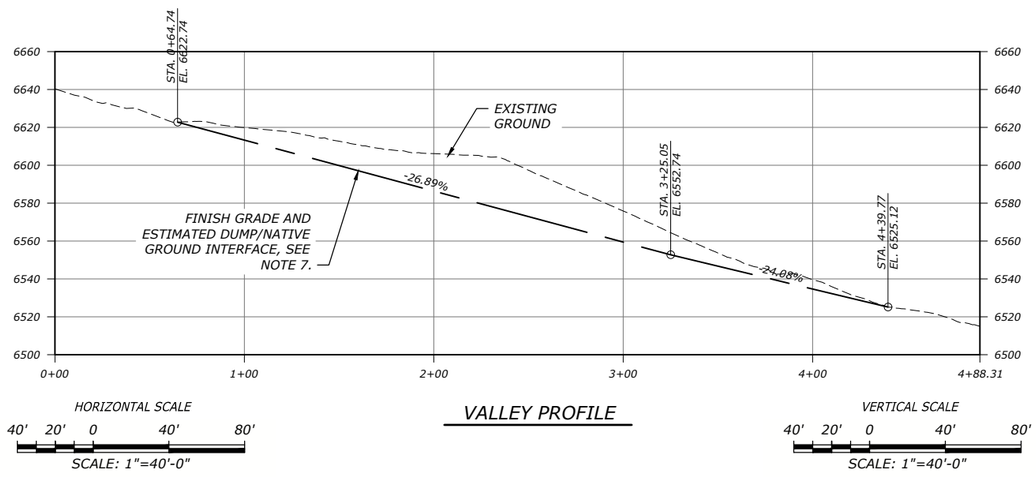
CERCLA PROJECT
HENNESSY CREEK DIVERSION
ALTERNATIVE 2

H-2

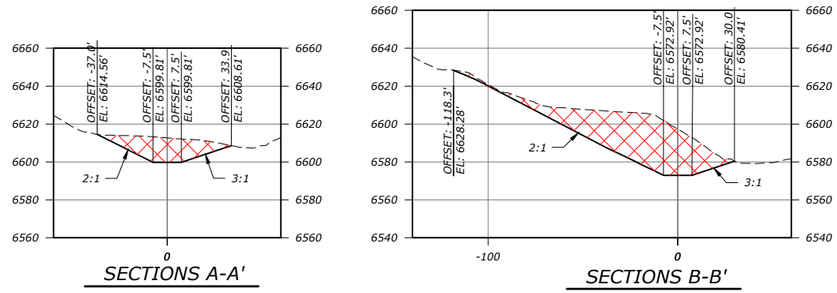
JUNE 2021



PROPOSED CONDITIONS



VALLEY PROFILE



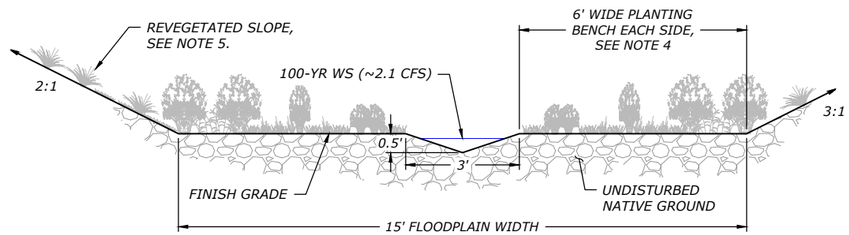
VALLEY SECTIONS

NOTES:
1. PROPOSED CHANNEL OMITTED FROM VALLEY SECTIONS FOR CLARITY.

HORIZONTAL SCALE
40' 20' 0 40' 80'
SCALE: 1"=40'-0"

VERTICAL SCALE
40' 20' 0 40' 80'
SCALE: 1"=40'-0"

PROPOSED CHANNEL OBJECTIVES					
REACH	VALLEY LENGTH (FT)	CHANNEL LENGTH (FT)	SINUOSITY	VALLEY SLOPE (%)	CHANNEL SLOPE (%)
DMEA DUMP SITE EPHEMERAL CHANNEL	375	385	1.03	26.0	25.4



TYPICAL CHANNEL SECTION
NTS

NOTES:
1. THE EXISTING EPHEMERAL STREAM MAY BE PIPED AROUND THE WORK AREA DURING CONSTRUCTION.
2. DUMP MATERIAL WILL BE REMOVED DOWN TO NATIVE MATERIAL AND THE CHANNEL WILL BE CONSTRUCTED WITHIN NATIVE GROUND. IMPORT OF STREAMBED MATERIAL IS NOT ANTICIPATED.
3. ROCK SLOPE ARMORING AT VALLEY TOE NOT ANTICIPATED.
4. REVEGETATION IS EXPECTED TO CONSIST OF ROBUST PLANTING OF ALDERS AND NATIVE SPECIES AT THE VALLEY TOE AND RIPARIAN PLANTING AND SEEDING THROUGHOUT THE 6' WIDE PLANTING BENCH.
5. UPLAND PLANTING AND SEEDING IS ANTICIPATED FOR ALL DISTURBED SLOPES. DISTURBED SLOPES MAY REQUIRE MULCHING AND/OR TACKIFIER.
6. NEW CHANNEL AND FLOODPLAIN WILL BE FIELD-FIT BASED ON ACTUAL DUMP/NATIVE GROUND INTERFACE ENCOUNTERED DURING CONSTRUCTION.
7. DUMP/NATIVE GROUND INTERFACE ESTIMATED FROM BEST AVAILABLE DATA. INTERFACE MAY BE REVISED WITH ADDITIONAL FUTURE FIELD DATA.

Applied Science & Engineering

WORKING DRAFT FOR REVIEW AND REVISION

STIBNITE GOLD PROJECT - DMEA DUMP SITE

CONCEPTUAL PROPOSED PLAN

FOR PERPETUA RESOURCES IDAHO, INC

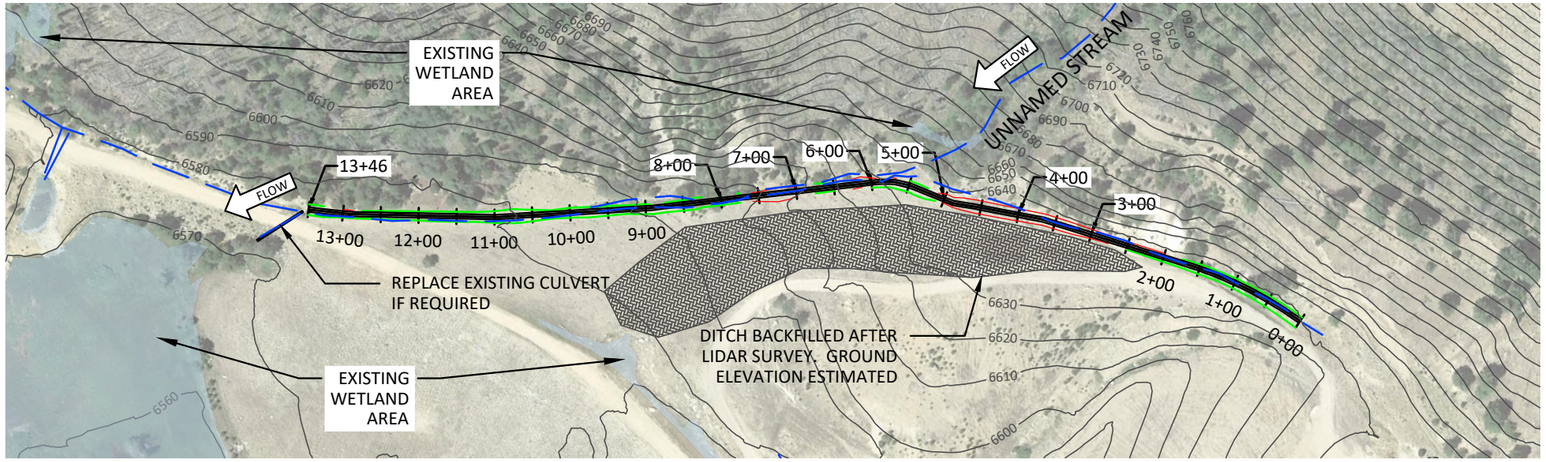
DMEA DUMP SITE CHANNEL

VALLEY COUNTY, ID

DATE: MARCH 2021
DESIGNED: JY
APPROVED: --

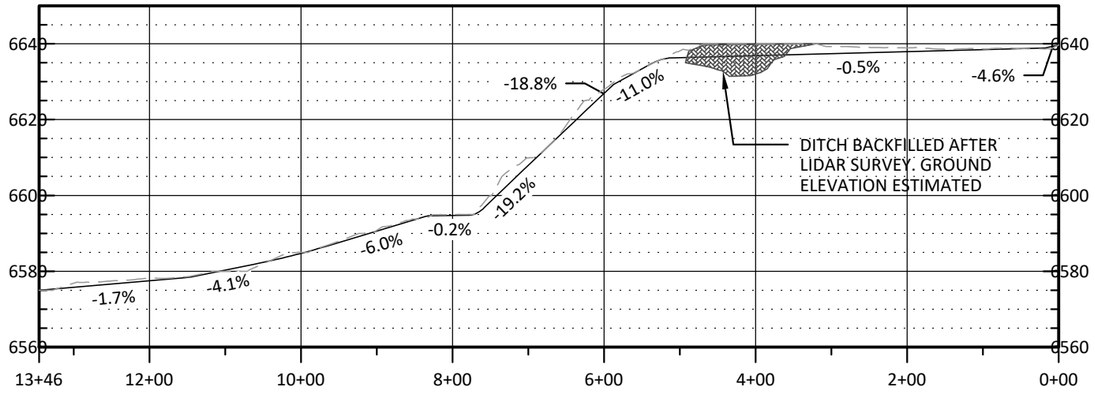
DRAWING NAME
DMEA-DUMP
PROPOSED CONDITIONS

DRAWING NO.
C1
SHEET 1 OF 1



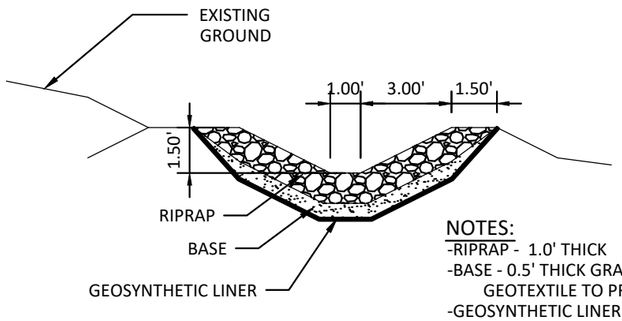
PLAN

SCALE: 1" = 200'



PROFILE

HORZ. SCALE: 1" = 200'
VERT. SCALE: 1" = 40'



NOTES:
-RIPRAP - 1.0' THICK
-BASE - 0.5' THICK GRAVEL OR NON-WOVEN GEOTEXTILE TO PROTECT LINER
-GEOSYNTHETIC LINER TYPE AND NEED FOR BEDDING, BASE, AND ANCHORING TO BE DETERMINED IN SUBSEQUENT DESIGN PHASES

TYPICAL SECTION

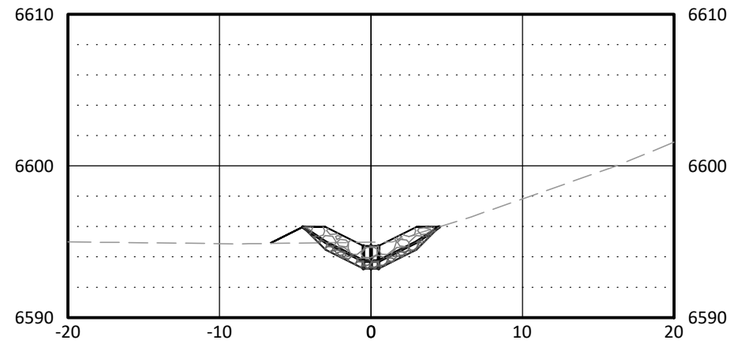
SCALE: NTS

SHEET KEY NOTES:

A DITCH TO BE LINED WITH GEOSYNTHETIC LINER, BASE MATERIAL AND RIPRAP SIZED TO BE STABLE AT 100-YR DESIGN FLOW. UPSTREAM AND DOWNSTREAM LIMITS OF WORK AND LINED/UNLINED SEGMENTS WILL BE DETERMINED AFTER STREAM DIVERSION CHANNEL FIELD INVESTIGATIONS.

B REPLACE EXISTING CULVERT TO PASS 100-YEAR FLOW AND ACCOMMODATE TRAFFIC LOADS IF REQUIRED BASED ON FIELD INVESTIGATION.

SMELTER FLATS ALT 1		
ITEM	QUANTITY	UNIT
EXCAVATION - CUT	640	CY
BACKFILL - FILL	172	CY
RIPRAP	370	CY
BASE	185	CY
GEOSYNTHETIC LINER	16,320	SF



SECTION 8+00

SCALE: NTS

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PERPETUA RESOURCES

CERCLA PROJECT

SMELTER FLATS DIVERSION ALTERNATIVE 1

S-1

JUNE 2021